

JAPAN

EDICT OF GOVERNMENT

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JIS A 1304 (1994) (English): Method of fire
resistance test for structural parts of buildings

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*The citizens of a nation must
honor the laws of the land.*

Fukuzawa Yukichi

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JAPANESE INDUSTRIAL STANDARD

**Method of fire resistance
test for structural
parts of buildings**

JIS A 1304—1994

Translated and Published

by

Japanese Standards Association

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

Method of fire resistance test for structural parts of buildings

A 1304-1994

1. Scope This Japanese Industrial Standard specifies method of fire resistance test for structural parts of buildings such as wall, column, beam, floor (inclusive of ceiling), roof, etc.

Remarks 1. The loaded heat test specified in 6., watering test specified in 7. or shock test specified in 8. shall be carried out where necessary.

2. The construction that passed the test shall be classified as follows:

Classified by heat test:	30 min heat	1 h heat
	2 h heat	3 h heat
	4 h heat	

In case of existence of other tests	{	Loaded heat test	L
		Watering test	W
		Shock test	S

Example of symbol: 2 h heat WS — Product that passed the 2 h heat test and also passed the watering test and shock test

3. The following standard is cited in this Standard:

JIS C 1602 Thermocouples

4. The units and numerical values in { } in this Standard are based on the traditional units and appended for informative reference.

2. Test piece

2.1 Test piece shall be of the same construction as that used practically, if there is partial difference in fire resistance, the part regarded as weak in fire resistance shall be included.

2.2 In case where the test piece has hollow portion, the test piece shall be made so as to seal the circumference and reverse side for wall and floor, and both ends for column and beam.

Informative reference: In case of the construction made up of steel pipe filled up with concrete or the like, as there is possibility of explosion of test piece caused by high pressure steam due to the water content of the filler, the test piece shall be made by drilling holes on the steel pipe for safety.

2.3 Reference size of test surface of test piece shall conform to Table 1.

Table 1

Structural parts	Size cm			Section
	A	B	C	
Wall	Height 240, width 180 min.	Height 180, width 90	Height 90, width 90	Thickness shall be the same as actual one.
Floor	Length 240, width 180 min.	Length 180, width 90	—	
Roof				
Column	Height 240 min.	Height 150		Section shall be the same as actual one. Length of side or diameter of steel may be 40 cm min., however, without changing thickness of covering material for steel.
Beam	Length 240 min.	Length 150		

2.4 The test pieces of steel structural column and beam shall be, besides in conformity with 2.3, the section of that steel shall conform to Table 2. In case where the steel section of actual structure is smaller than this value, however, shall conform to the actual section.

Table 2

Structural parts	Steel sectional area cm ²	Size cm
Column	120 max.	Side or diameter: about 30
Beam	100 max.	Depth: about 40

2.5 Concerning test pieces for watering test and shock test, in case where it is recognized that there is no difference on fireproofing and structure, the test piece of wall may be substituted for the test pieces of floor, column and beam.

2.6 The test piece shall be dried in well ventilated room for term or so given in Table 3. In case where the dried state is made by artificial drying or it is confirmed by the suitable test method that it is in air dried state, however, this term may be shortened.

As for the metallic or glass products, there is no need of drying.

Table 3

Classification	Summer	Winter
Wet method such as treated with concrete, mortared	2 months	3 months
Dry method such as lined with asbestos slate	1 month	1 month

3. Heating furnace

3.1 Heating furnace shall be able to make temperature change corresponding with time shown in 4. almost uniformly on whole test surface.

3.2 Heat source of heating furnace shall be town gas, propane, fuel oil and other suitable fuels, and its flame will be able to reach direct sufficiently the test piece.

3.3 Fixing frame of test piece shall be heat-proof and constructed so as to be able to hold test surface at the appointed position.

3.4 Wall shall be heated from one side at the vertical position, column shall be from four sides at the vertical position, beam and floor shall be from under side at the horizontal position.

3.5 The heating furnace for loaded heat test shall be provided with the device which is able to apply a specified load on the test piece during heating.

4. Grade of heating Heating temperature shall conform to reference curves shown in Table 4 and Attached Fig. 1, and the grade of heating shall be classified as 30 min heat, 1 h heat, 2 h heat, 3 h heat and 4 h heat, whose heating durations are 30 min, 1 h, 2 h, 3 h and 4 h respectively.

Table 4

Elapsed time (min)	5	10	15	20	25	30	35	40	45	50	55	60
Heating temperature (°C)	540	705	760	795	820	840	860	880	895	905	915	925

Elapsed time (min)	65	70	75	80	85	90	95	100	110	120	130	140
Heating temperature (°C)	935	945	955	965	975	980	985	990	1000	1010	1015	1025

Elapsed time (min)	150	160	170	180	190	200	210	220	230	240
Heating temperature (°C)	1030	1040	1045	1050	1060	1065	1070	1080	1085	1095

5. Heat test

5.1 Part other than the test surface shall be covered with fire brick or the like so as to cut off the flame. Further, if there is possibility of heating of the part other than test surface on account of gap between them, it shall be heated after applying suitable treatment such as filling up with asbestos or the like.

5.2 As for the construction having gas permeability, cavity, joint, etc., the heating method shall be adopted so that the furnace inside pressure of heating side of test piece will become higher than the atmospheric pressure.

For this purpose, by fitting the manometer or the like on the test surface and shall be confirmed that at least about $\frac{1}{2}$ of heating surface is receiving the furnace inside pressure which is higher than the atmospheric pressure.

5.3 Heating temperature shall be measured with CA thermocouple of 1 mm in diameter and Grade 0.75 or superior in performance specified in JIS C 1602.

5.4 Hot junctions to measure the heating temperature shall be set as shown in Attached Fig. 2, center and middle points between center and end part on the center line of test surface for wall, floor and roof and symmetrically as for column, beam, and shall be made as reference the number of thermocouples not less than the numerals given in Table 5.

The thermocouple used for measuring the heating temperature shall be inserted in the tip sealed quartz, steel or porcelain protecting tube having inside diameter of about 1 cm. The hot junctions shall be placed at the positions apart about 3 cm from the test surface and parallel to the test surface for not less than 10 cm, respectively.

Table 5

Unit: piece			
Size of test piece \ Structural parts	Column	Beam	Wall, floor, roof
A	12 (8)	9 (7)	9 (5)
B, C	8 (6)	6 (5)	5 (3)

Remarks: Numerals in brackets show minimum value.

5.5 Heating shall be carried out, in the manner to meet the reference curve specified in 4., the temperature indicated by the thermocouple specified in 5.4 will reach the heating time of scheduled grade of heating. In case of need, however, it may be heated more than the heating time of scheduled grade of heating.

5.6 Heating temperature shall be measured within every 2 min up to 30 min and after 30 min within every 5 min. Tolerance on the mean furnace inside temperature for the reference curve shall be, in the heating time-temperature area, within $\pm 10\%$ up to one hour of heating time, $\pm 7.5\%$ up to two hours and $\pm 5\%$ for exceeding two hours. With the temperature higher than the tolerance, when passed the provisions of 5.10, however, the above requirements need not be fulfilled.

5.7 At the time of making test piece, on the main steel surface needed for yield strength structurally, CA thermocouple of 0.65 mm in diameter and Grade 0.75 or superior in performance specified in JIS C 1602 shall be fitted at center and middle points between center and end part of test surface for wall, floor and roof and symmetrically as for column and beam, and number of pieces shall be not less than the numerals given in Table 6, and the steel temperature at the time of test shall be measured.

Table 6

Unit: piece			
Size of test piece \ Structural parts	Column	Beam	Wall, floor, roof
A	9 (6)	6 (5)	5 (4)
B, C	6 (4)	4 (3)	3 (2)

Remarks: Numerals in brackets show minimum value.

5.8 Concerning wall and floor, the temperature of reverse side of heating surface (inclusive of joint and other weak portion. Hereafter referred to as "reverse side temperature") shall be measured. The reverse side temperature shall be measured with CA thermocouple of 0.65 mm in diameter and Grade 0.75 or superior in performance specified in JIS C 1602. Five or more hot junctions (3 for B, C test piece) shall be arranged (refer to Attached Fig. 2), on the test piece and shall be covered by close adherence with Japan cedar board of 10 cm × 10 cm min., thickness of 1.5 cm at air dried state.

Moreover, in case of heating for over the heating time of scheduled grade of heating, the measurement shall be carried out by adding more hot junctions than above-mentioned, and by covering with close adherence of asbestos board of 10 cm × 10 cm min., thickness of 1 cm at air dried state.

5.9 Surface temperature and reverse side temperature of steel shall be measured even after completion of heating until showing descent. The temperature shall be measured within every 5 min.

5.10 As a result of heat test, if test piece conforms to the following requirements, the test shall be considered to be passed.

- (1) During heating, there is no change regarding as harmful for fireproof and strength structurally such as deformation, destruction, coming off, etc.

Remarks: If the exfoliation is limited to the surface layer due to the local explosion, and even if the partial explosion, big crack, exfoliation, coming off, etc. occurs on the heated side of laminated material, if reverse side material or core material does not come under them, the material shall be accepted.

- (2) During heating, on wall, floor and roof, there shall be no crack which allows flame to penetrate.

Remarks: When recognized that the crack reaches the reverse side, put cotton wool on that cracked part, and if it does not catch fire, it shall be accepted.

- (3) Concerning wall and floor, the reverse side temperature specified in 5.8 shall not exceed 260°C. In case of reverse side temperature of outer wall heated from indoor, however, the above requirements need not be fulfilled.

When heated over the heating time of scheduled grade of heating, obtain the time by adding the heating time of scheduled grade of heating to the time which the temperature indicated by the thermocouple covered with asbestos board, after completion of heating showed until descent. And at this obtained time the temperature indicated by thermocouple covered with Japan cedar board shall conform to this requirements.

- (4) Maximum and mean of steel temperature specified in 5.7 shall not exceed the temperature shown in Table 7.

When heated over the heating time of scheduled grade of heating, at the time obtained by adding the heating time of scheduled grade of heating to the time after completion of heating showed until descent, the temperature shall conform to this requirements.

Table 7

Unit: °C

Structural parts Kinds of structure		Column, beam	Floor, roof, wall (exclusive of non-proof stress outer wall)
Steel framed reinforced concrete structure Reinforced concrete structure Reinforced concrete panel, etc.	Max. temperature	500 max.	550 max.
Prestressed concrete structure	Max. temperature	400 max.	450 max.
Steel structure	Max. temperature	450 max.	500 max.
	Mean temperature	350 max.	400 max.

- (5) During heating, all structural materials shall not flame remarkably and after completion of heating any ember shall not remain for 10 min or more.

6. Loaded heat test

6.1 Concerning the fire resistance test conducted on A test piece for main structurally proof stress parts, the judgement of acceptance or rejection may be carried out in accordance with loaded heat test, disregarding 5.10 (4).

6.2 By loading the weight which will produce the stress intensity equivalent to 1.2 times the long-term permissible stress intensity, the heat test specified in 5. shall be carried out. However, as for the roof not utilized as housetop, by dividing roof area every 1 m², and concentrated load of 637 N (65 kgf) shall be applied to the central point of each divided part.

6.3 As a result of loaded heat test, if the main structural materials did not show any rupture on proof stress and conform to each item exclusive of 5.10 (4), the test is considered to be passed. Here, "did not show any rupture" shall mean that changed amount of deformation of test piece such as deflection or elongation, etc. did not change abruptly, moreover, as for floor the maximum deflection (cm) shall not exceed $\frac{1}{10000}$ of the square of distance (cm) between supports of test piece, and also, as for roof the maximum deflection (cm) shall not exceed $\frac{1}{6000}$ of the square of distance (cm) between supports of test piece.

7. Watering test Test piece shall be heated in conformity with the method of testing specified in 5. for 30 min (10 min for 30 min heat) or more. Immediately after heating at the horizontal distance of 5 m and at the angle of 45° against the surface, the watering test shall be conducted on the nearly central part of the test piece with the nozzle bore of 12.7 mm, nozzle pressure of 137.2 kPa (1.4 kg/cm²) for 2 min. If there is no serious break or missing, the material shall be accepted.

Remarks: The conversion to the value based on the International Unit System (SI) when testing by means of the tester or measuring instrument indicating the values based on the traditional unit system shall be made in accordance with the following formula:

$$1 \text{ kgf} = 9.80 \text{ N}$$

8. Shock test The test piece heated by the method of heating specified in 5. for 30 min (10 min for 30 min heat) or more, shall be placed horizontally with the test surface upwards (in case of floor or ceiling, with the surface downwards), and egg-apple-shaped weight of 1 kg, 5 kg or 10 kg in mass as shown in Attached Fig. 3, shall be dropped from the height as shown in Table 8 on the weak point of test piece according to the kind of structural part, and when there is no exfoliation of over the whole thickness of fire resistant covering material nor holes reach the reverse side, the test piece shall be accepted.

Table 8

Items	Grade of heating Structural parts	30 min heat		1 h heat		2, 3, 4 h heat	
		Floor, roof	Column, wall	Floor	Column, wall	Floor	Column, wall
Mass of weight kg		1	1	5	5	10	10
Dropping height cm		200	100	200	100	200	100

9. Judgement and report

9.1 The number of times of heat tests in 5. shall be as given in Table 9 according to the size of test piece and its combination, and all the tests shall be passed at each time.

Table 9

Structural parts	Size of test piece and number of times of tests	Symbol
Wall (1)	Combination of once for A size and once for C size test piece	AC
	Twice for B size test piece	BB
	Three times for C size test piece	CCC
Floor, column, beam, roof	Combination of once for A size and once for B size test piece	AB
	Three times for B size test piece	BBB

Table 9. (continued)

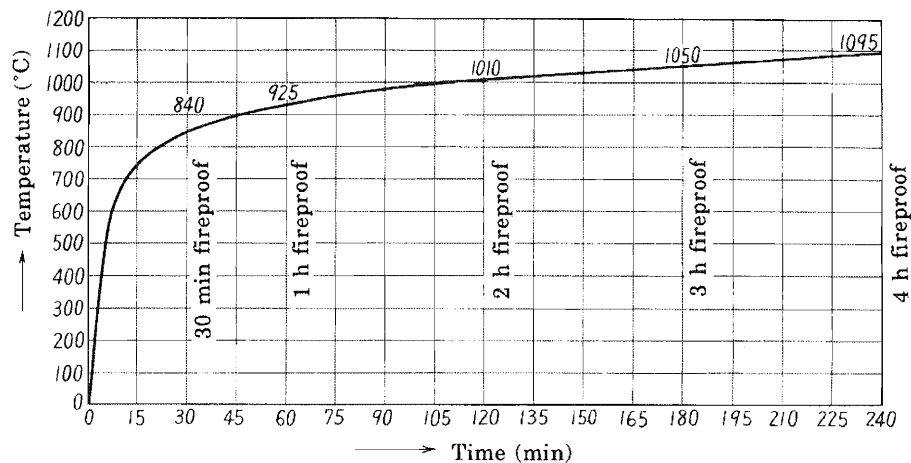
Note (1) As for the wall having asymmetric material construction on both sides, the test shall be carried out the number of times given in above, on both sides respectively. Concerning the structural parts correspond to the followings, however, the judgement should not be made only by the C test piece.

- (a) Having thick total thickness containing air layer or the like.
- (b) Having the possibility of causing harmful deformation for fire prevention by heating such as gap, crack, coming off, etc. due to change of elongation, contraction or deflection of materials.

9.2 The number of times of tests of loaded heat test in 6., watering test in 7. and shock test in 8. shall be twice each and the test shall be passed at each time.

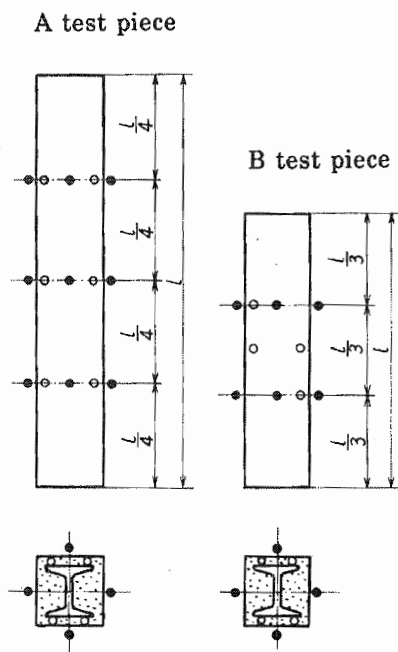
9.3 On the report of the test results, name of kind of construction, details of materials used (inclusive of specific gravity, moisture content and other qualities), shape and size of test piece, grade of heating, heat source, heating temperature, reverse side temperature and steel temperature, and their mean values and measured points, maximum value and time required to reach that value, important items of observation concerning fire prevention, judgement and its ground of results, fuel consumption, date of test, name of test institution and name of person in charge of test shall be mentioned.

Attached Fig. 1

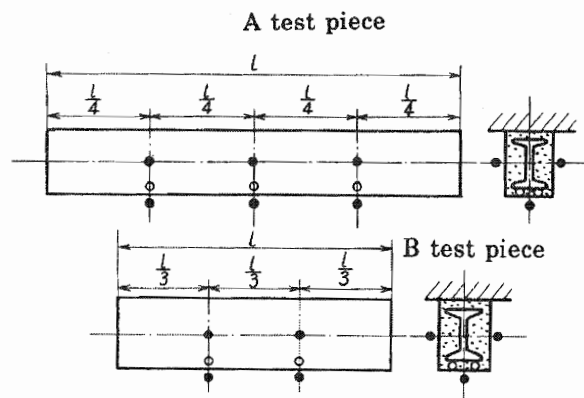


Attached Fig. 2. (Reference example of temperature measuring points)

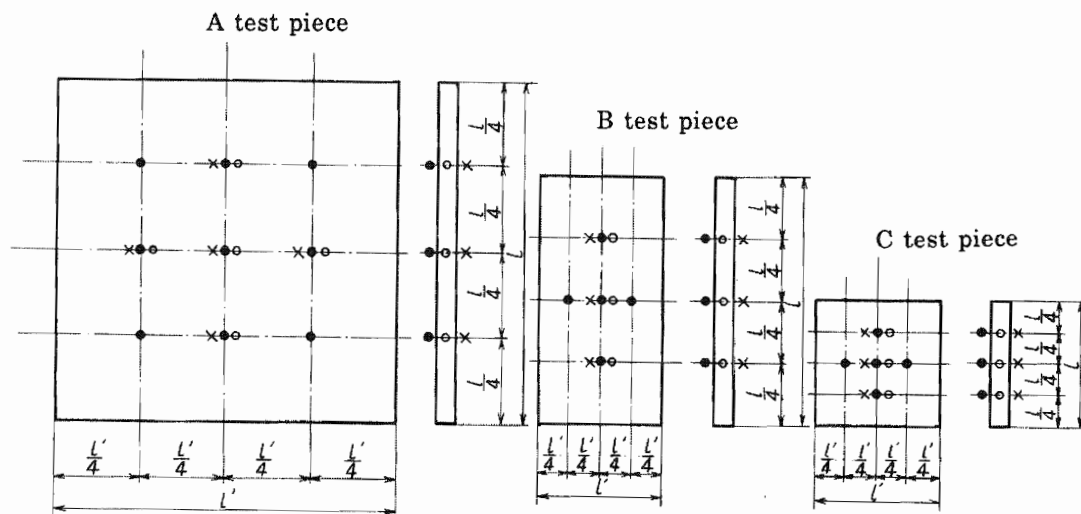
a. Column



b. Beam



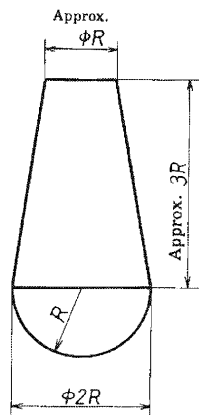
c. Wall and floor



Explanatory notes: ●..... measuring point of heating temperature
○..... measuring point of steel temperature
×..... measuring point of reverse side temperature

10.
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Attached Fig. 3



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